CLAIMS

1. A time delay beamformer comprising a plurality of input channels, each channel having associated sampling means arranged to sample an input signal carried upon the input channel at a plurality of points in time to produce a plurality of sampled signals; processing means arranged to receive said input signals and said sampled signals, or signals indicative of each of the input signals and each of the plurality of sampled signals, and arranged to generate processed signals therefrom; steering time delay means arranged to introduce a steering time delay to said processed signals, or to signals indicative of said processed signals to produce at least two delayed signals; and summation means arranged to generate a beamformed output signal from the delayed signals, or from signals derived from the delayed signals.

2. A beamformer according to claim 1 wherein the processing means is arranged to output a plurality of processed signals, and the time delay means is adapted to apply a time delay on a plurality of processed signals to form a plurality of time delayed signals, and the summation means is adapted to generate a beamformed output signal from said plurality of time delayed signals.

3. A beamformer according to claim 2 wherein there are as many, or about as many, processed signals produced by the processor as there are input signals.

4. A beamformer according to claim 2 or claim 3 wherein there are as many, or about as many, time delayed signals as processed signals.

5. A beamformer according to any preceding claim wherein the adaptive processing means is arranged to generate an input data covariance matrix from the input channels and the sampled signals.

6. A beamformer according to claim 5 wherein the processing means is arranged to apply steering vectors to each entry in a matrix derived from the covariance matrix, or vice versa.

7. A beamformer according to any preceding claim wherein the processing means is arranged to generate steering time delays, or at least one steering time delay, which is/are passed to the time delay means.

8. A beamformer according to any preceding claim wherein each time delay means is spaced by a time that is approximately equal to the pulse repetition interval of a transmitted, pulsed signal.

9. A beamformer according to any preceding claim in which the time delay means comprise time delay taps derived from input channels.

10. A beamformer according to any preceding claim comprising n input channels, each input channel having m time delayed means.

11. A beamformer according to claim 10 comprising nm, or less than nm, time delay means arranged to generate nm, or less, steered beam directions.

12. A beamformer according to any preceding claim wherein the channels comprise a plurality of signal sensors adapted to detect an incident wave and signal transmit lines adapted to transmit channel signals from the sensors to the processing means, the time delay means comprising tapped lines taking tapped signals from different places along the lengths of the signal transmit lines such that the processing means receives tapped, time delayed signals from the tapped lines, as well-as the channel signals from the signal transmit lines, the arrangement being such that the time delays of the tapped signals are fixed for each tapped signal.

13. A beamformer according to any preceding claim wherein the steering time delays applied by the steering time delay means to a particular input channel are variable depending upon the signals received by the other input channels.

14. A beamformer according to any preceding claim wherein the processing means is programmed to apply adaptive weights to the signals of the input channels, the weighting applied to the signal of specific input channels being dependent upon the signals received from other input channels.

15. A method of time delay beamforming comprising the steps of:

i) tapping input signals of a plurality of detected signal inputs at regular time intervals to produce a plurality of time delayed sampled signals;

ii) processing input signals, or signals indicative of the input signal(s), and the time delayed sampled signals, or signals indicative of the sampled signals, to reject unwanted signal components therefrom, to produce processed signals, or at least one processed signal;

iii) applying a steering time delays to the processed signal(s), or signal(s) indicative of the processed signal(s) to produce at least one delayed signal; and

iv) generating a beamformed output from the delayed signal(s), or from a signal indicative of the delayed signal(s).

16. The method of claim 15 including generating a covariance matrix from the input channels and the sampled signals.

17. The method of claim 16 including generating an nm x nm dimensional covariance matrix where n is the number of input channels and m is a number of taps.

18. The method of claim 17 including generating nm, or less, steered beam directions, using nm, or less than nm, time delay means.

19. The method of any one of claims 16 to 18 including applying ~~steering vectors to each entry in the covariance matrix~~.

20. The method of any one of claims 15 to 19 including generating steering time delays, or at least one steering time delay, and passing the steering time delays to time delay means and delaying processed signals produced by the processor by the steering time delays.

21. The method of any one of claims 15 to 20 comprising tapping the input signals at times that are spaced by approximately the pulse repetition interval of a transmitted, pulsed signal that is being detected by the beamformer.

22. The method of any one of claims 15 to 21 wherein the input signals are adaptively weighted to produce the processed signals.

23. A method of reducing the computational load associated with beamforming comprising the steps of:

i) generating an estimated covariance matrix from a plurality of time delay tapped input channels;

ii) forming an adaptive weight vector for a space-time channel from a column of the inverse of the covariance matrix;

iii) applying the adaptive weight vector to the space-time channel to form an interferance cancelled spatial channelp; and

iv) applying a time delay to the spatial channel.

24. The method of claim 23 including summing the delayed at least one output channel signal to form a beamformed output.

25. A method of increasing the resolution of a sideways sensing sensor array comprising the steps of:

i) receiving a plurality of input channel signals;

~~ii)~~ ~~tapping a plurality~~ of time delayed, tapped, sampled signals from each of the input channels; and

iii) applying space time adaptive processing to the plurality of input channel signals and sampled signals so preserve the linear relationship between Doppler frequency and angle of return.

26. The method of any one of claims 15 to 25 comprising, or a beamformer of any one of claims 1 to 14 configured for, beamforming from a plurality of beam directions simultaneously or substantially simultaneously.

27. The method or beamformer of claim 26 comprising beamforming from at least 5, or 10, or 20, or 30 directions simultaneously or substantially simultaneously.

28. A radar, or sonar, or telecommunications device comprising a time delay beamformer according to any one of claims 1 to 14, or using the method of any one of claims 15 to 27.